Under the Resource Management Act 1991

In the matter of an application for a Water Conservation Order pursuant to s201 of the Act

By **THE NEW ZEALAND & NORTH CANTERBURY FISH & GAME COUNCILS AND THE NEW ZEALAND RECREATIONAL CANOE ASSOCIATION**

STATEMENT OF EVIDENCE OF DR VAUGHAN FRANCIS KEESING ON BEHALF OF THE HURUNUI WATER PROJECT

2009

Qualifications and Experience

1. My full name is Vaughan Francis Keesing. I am a Senior Ecologist and principal with the consulting firm of Boffa Miskell Ltd, Christchurch. I hold the qualification of Doctor of Philosophy (PhD) in Ecology.

2. My base skills lie in community ecology, and in measuring and understanding interactions between species and their environment. I have specialist skills in the areas of limnology, entomology, zoology and botany and have worked extensively in freshwater and terrestrial habitats. My PhD thesis and subsequent research focuses on community and habitat inter-relations and invasion-disturbance ecology.

3. I have been practising as an ecologist for the last 13 years, and have worked in a variety of locations including the West Coast, Canterbury, Central North Island, Lower North Island, the Far North, Auckland Region and the Bay of Plenty.

4. During that time I have undertaken a wide range of ecological surveys of natural and semi-natural sites, incorporating both botanical and wildlife values. I have provided assessments of values and significance of sites for many Councils and private clients; and ecological effects of a range of activities on those sites.

5. I have undertaken research studies and assessments of at least 7 hydro generations systems and of over 20 subdivisions that included aquatic issues, of 42 Northland streams (four years of SES long term monitoring for Council), I have surveyed over 300 streams and rivers in that time as well as assessed numerous roading, mining, quarrying, water take and other developments involving water use and discharges. I am thus very familiar with measuring aquatic ecosystems, of interpreting the data in regard to value, uniqueness and sensitivity, the changes water use, diversion, loss and discharge in regard to aquatic community response and aquatic systems in general. I have also helped design and assess stormwater devices, fish passage devices, new stream sections and wetlands in relation to improving water quality and as habitat for aquatic species.

6. I have read the Code of Conduct for expert witnesses and have complied with this code in the preparation of my evidence.

Executive Summary

7. Based on the array of evidence I have been able to collect and access, of the 150 km of the North Branch main stem of the Hurunui and the 50km of river in the South Branch, I can, by ranking quantitative data values for various parameters (such as trout number per kilometre and aquatic invertebrate densities) only recommend that around 4km (that river reach immediately below the Lake Sumner Outlet) of the Hurunui system be considered as "Outstanding" in terms of trout abundance and trout habitat. I do not consider that 4km (2%) of the primary river system is sufficient to recommend that the waterways of the catchment in their entirety be considered Outstanding, especially where Outstanding is a test of "*quite out of the ordinary on a national basis"* or otherwise exceptional.

Scope Of Evidence

8. The purpose of my evidence is two fold:

9. To assess the Hurunui River in terms of section 199(2)(b)(i) of the Water Conservation Act, i.e*. "Outstanding as a habitat for terrestrial or aquatic organisms";* and

10. To discuss what changes could occur to those "outstanding" values in regard to potential changes in water management of the upper catchment river and whether such changes would negate or adversely affect the values purported to support a conservation order.

11. This will involve :

    i. Discussion of the Applicant's case and my terms of reference and methodology;

ii. Discussion of what organisms the applicant has considered under this section and which other organisms are relevant; which leads to

iii. Discussion of the riverine bird life and habitat; and

iv. Discussion on the "outstanding" label attached to the Hurunui by Fish and Game and the New Zealand Canoe Association (the Applicants) with respect to the trout fishery (by which I mean the fish populations and not the fisherpersons ability to catch trout);

12. To achieve the above I use published salmonid data and my own field work to allow discussion of trout numbers and published and my own collected aquatic macroinvertebrate data to approximate the rivers productivity and physical habitat elements. This leads me to discuss the relative numerical "ranking" of trout per kilometre and value in terms of aquatic community production of the upper Hurunui River (that area above the Mandamus confluence). I also briefly discuss the terrestrial river and lake associated organisms using my own and published bird data to numerically rank the river in terms of bird species, number and habitat quality. These data apply only to a Canterbury Regional context.

Introduction : Information and data sources for this evidence

13. In preparing this evidence I have utilised a wide array of published and pseudo-published (such as Council reports and privately commissioned reports) literature relating directly to the Hurunui environs, as well as to trout assessments regionally and nationally and to other technical matters relevant to the ecology of the Hurunui catchment and to making value and ranking assessments. Of greatest importance has been the drift dive data and reports of Jowett 1990, Teirney & Jowett (1990), Jellyman & Graynorth (1994), Ryder Consulting Limited (2006), Meredith et al 2003 and O'Donnell 2000.

14. In addition to reports and published literature I rely on my own data that I have collected from field work in the South Branch of the

Hurunui and in the North branch of the Hurunui between November 2008 and March 2009. In the South Branch of the Hurunui I have undertaken a 10km electric fishing survey above the "gorge" (from the gorge to just above lake Mason confluence), a spawning gravels and general aquatic physical habitat survey over the same area; a standard observational transect riverine bird presence and nesting survey over the same reach; an extensive vegetation survey of both the South Branch valley and down stream of Lake Sumner; a 10km drift dive survey from the gorge in the South Branch to the South Branch road bridge, temperature monitoring through data loggers in the South Branch since November 2008; an IFIM transect survey in the lower South Branch (which continues to be assessed) and an aquatic macroinvertebrate survey of 18 sites in the different aquatic habitats from the gorge to the upper lake Mason confluence area. In addition I have walked, driven and otherwise observed the Hurunui River at other various locations at various times.

15. During the preparation of the final draft of this evidence I also had the opportunity to review the expert evidence of the applicants: Dr Young, Dr Jellyman, Mr Unwin, Mr Stewart and Dr Hughey (for Forest and Bird and DOC).

The applicants case and my terms of reference

16. The Applicants of the Conservation Order (New Zealand Fish and Game and the New Zealand Recreational Canoeing Association) propose a Conservation Order pursuant to Part 9 of the RMA on the Hurunui "*in the hope that its outstanding amenity and intrinsic values will be preserved*" [adding later also] *outstanding characteristics* of the upper Hurunui waters".

17. In appendix B of their initial application the applicant's address, one of the sections to be addressed, section 199(2)(b)(i) *Outstanding as a habitat for terrestrial or aquatic organisms.* There they state that they seek "*preservation of the outstanding brown trout habitat afforded by these* [upper] *waters in their natural state*", as well as protection for the lower river because of the contribution that portion makes to the

outstanding brown trout habitat in the upper river, particularly [or specifically] fish passage.

18. The evidence brought to the application by the applicants in this matter is anecdotal in part, addresses fishability and not fish habitat in part, water quality in part and in the main provides data on numbers of trout per river area where that information is available. A large part of the evidence focuses on their own data collection on trout numbers between the Sisters Stream confluence and the outlet of Lake Sumner.

19. The order requested initially covers all waterways of the Hurunui River catchment above the Mandamus confluence (first bullet point) and then the main stem of the lower Hurunui to the sea outlet. However, later in the application the applicants set aside as to not be included Lakes Mary, Marion and Raupo lagoon and the tributaries feeding into these water bodies.

20. From the Applicant's perspective then, it appears under section 199 that they argue that those waterways applied for are **outstanding brown trout habitat**, and for no other reason.

21. Given the broad nature of the wording in section 199 (terrestrial and aquatic organisms) but considering the purpose being "**Water**" focused, I interpret the Act as requiring consideration of all of the fish species, all of the aquatic macroinvertebrate species, all of the aquatic plant species and the plant and animal species on the edges of the water dependent on the water or whose habitat is a product of the water.

22. For the Hurunui River upper sections, in a somewhat limited way, means the native fish species resident (eel, bully, galaxids) as well as salmon and trout, a range of native emergent and submerged aquatic plants, the aquatic invertebrate community (but particularly the diversity and densities of those communities and their role in the productivity of the system) as well as the riverine turf lands and gravels which are habitat to a range of riverine specialist or seasonal reliant bird species.

23. The applicant however (at least in the initial application), considered only brown trout habitat.

What is meant by "Outstanding"

24. The Trust's Legal Counsel advise me of the following:

    i. "The test as to what is outstanding is a reasonably rigorous one and that to qualify as outstanding a characteristic would need to be ***quite out of the ordinary on a national basis***" – (*Rangitata South Irrigation Ltd v NZ and Central South Island Fish and Game Council* EnvC C109/04 (emphasis added) also accepted in the *Mohaka River* case).

    ii. "Amenities should stand out on a national comparative basis. If one takes a national comparative approach, the fact that the wider region is well endowed with similar high-quality features may well suggest that particular waters do not stand out when considered in a national context." – *Rangitata South Irrigation Ltd v NZ and Central South Island Fish and Game Council* EnvC C109/04.

    iii. It is not necessary to establish that a characteristic is unique – what must be established is that the outstanding characteristic stands out in comparison with those of other rivers – *Kawarau River* case.

25. Central to my assessment is what is meant by "Outstanding". Outstanding is commonly held to be exceptional or well above the normal and clearly noticeable and the case law above supports that reasoning. The Oxford dictionary states "exceptional", the concise Collins dictionary: "superior, excellent". To me the above suggests the best few, top ranked, examples at a national level. For example in terms of a test result an A+ score is outstanding. The top 5% is "outstanding".

26. It appears to me that in regard to using rankings, where such can be applied, the National top 5% of listed features could be considered a reasonable measure of "outstanding". There will be variation in opinion on such a number but somewhere between the top 1% and 10% would be accepted by most people. As a mid-way point a top 5% I think represents an acceptable "exceptional "position.

27. Having reviewed the values and states of previous rivers with existing Conservation Orders (I list these in table 1), I note that many of these rivers do not have top 5% rankings for trout or water bird habitat.

Many are ranked below the Hurunui River in terms of these two criteria. I assume other criteria, such as wild and scenic values, or recreational values, in those cases were "outstanding".

28. In regard to brown trout values the applicant does not suggest what aspects of "trout habitat" make an outstanding one. For example is it the abundance of trout, their size, their health (visual quality), all, or a combination of the above, or the habitat qualities (productivity etc).

29. I have assumed that fish number per area and biomass are primary factors since these appear to be the focus of the applicant's evidence. My evidence does not consider the fisherman's fishing experience or ability to catch brown trout and hence the value as a "fishery".

Table 1. Rivers with a current Conservation Order. Those rivers in grey shade are the rivers which the applicants provide trout data for in their application:

Pre RMA	
Motu River	1984
Rakaia River	1988
Lake Wairarapa	1989
Manganuioteao River	1989
Lake Ellesmere	1990
Ahuriri River	1990
Grey River	1991
Under the RMA	
Rangitikei River	1993
Kawarau River	1997
Mataura River	1997
Buller River	2001 & 2008 amendment
Motueka River	2004
Mohaka River	2004
Rangitata River	2006
Oreti River	2008

30. I also note that the Conservation Order may also provide for "*scientific and ecological values*", ones I assume that are Outstanding also. In terms of ecological values my evidence addresses, as a whole, these values in the Hurunui, through addressing the birds, fish, plants and invertebrates. With regard to scientific values, I can only provide my professional opinion as to that value and am not aware from a species or community of ecological function and processes attribute that the Hurunui River and lakes in general are scientifically outstanding. The one exception to this may be Lake Marion because of its native pristine community and condition. The DOC Hurunui Mainland Island Area in the Headwaters of the South Branch where yellowhead and orange-fronted Parakeet (as well as other species) persist and are managed by DOC is valued for its terrestrial components which are not directly associated with the river and so I have not included that feature.

Summary evidence guide

31. I will discuss the terrestrial components first, being the river turf lands of the braided sections (those areas most influenced by the water regime), and the river birds found on them. I shall then discuss aspects of aquatic habitat, water quality, river productivity, then trout abundance, then aquatic vegetation, native fish and Didymo. Finally I shall discuss future potential river flow management and its possible effects.

32. I shall not discuss the fishability of the rivers or anything related to the recreational sport of salmonid fishing other than to make a brief comment on an assessment made by Mr Greenaway in 2001 regarding the South Branch.

Terrestrial organisms - riverine birds and their habitat.

33. In the main this means the river turf land vegetation and those water birds directly reliant on the river and lakes. I do not discuss river turf

reptiles and invertebrates, largely from an absence in data from which to do so.

Plants

34. The majority of the upper Hurunui is a single braid or a morphology that is not considered “braided”. The gravels and rivers edges are typical exposed cobble, gravels and boulders with edges in, and small “central” areas having transient covering of, exotic grasses and weeds, some native grasses and herbaceous plants. This is true of the exposed littoral zones of the lakes as well. Species such as hawkweed, *Hieracium, Hydrocotyle,* clover, creeping butter cup, ragwort, Yorkshire fog, *Gunnera* spp, bidibid, *Anisotome*, brown top, creeping bent, silvery hair grass, sweet vernal, lotus and thistle, with occasional ferns (*Blechnum*, shield fern and *Asplenium* spp.), carex grasses, and at the river bank edges Coprosma, mingimingi, fuchsia, hebe, five finger, flax and marble leaf spp. This is a very common assortment of riverine/riparian plants with no recorded threatened species.

35. I note that seven terrestrial plants with a threatened species status have been recorded in the past in the Hurunui River area (and lakes) (Armstrong 2006, Walker & Williams 2002, Molloy & Cambell 1979) but none of those records identified any of those plants within the upper river bed or in areas associated with the river of lake margins. Botanic surveys of large areas of the South Branch and Lake Sumner and immediate outlet of the North Branch by me and my team confirm those records.

36. The braided section of the middle-upper South Branch contains river associated native/exotic mixed turf lands. Low lying short stature vegetation on which many of the river birds nest and which is flooded seasonally.

37. These turf lands are largely comprised of matting cushion plants (*Racomitrium* and *Raoulia, Scleranthus*), *Colobanthus* spp. *Leptinella* spp, *Muehlenbeckia axillaris*, *Pimelia* spp., *Pratia* spp., *Poa* spp., as well as exotics species such as thistle, clover *Hieracium, Hydrocotyle, Hypochoeris*, brown top, silvery hair grass, sweet vernal.

38. While a significant habitat type for the banded dotterel and other river turf land breeding birds in that area, the vegetation community and habitat provided is not “Outstanding” in terms of size, composition, condition or any other measurable parameter.

Birds

39. The Hurunui River below the Mandamus confluence (i.e. on the plains) is known for a wide range of braided river and water bird specialists, many of which are nationally threatened including black-fronted tern, black-billed gull, banded dotterel, grey duck, Caspian tern and white-fronted tern. The lakes are known to support 15 species of water bird (Lewis 1983) and Australasian crested grebe (also nationally endangered) is known to reside at Lake Sumner. The Hurunui River was rated as of high value to wildlife by O’Donnell and Moore in 1983. Daly (2004) and Armstrong (2006) have reviewed and updated that information but not added to it or made re-evaluations of use here while O’Donnell in 2000 revised the values of each river in regard to birds and bird habitat.

40. Historically, when the rivers were ranked by the old SSWI (Sites of Special Wildlife Importance) system, the Hurunui River ranked as “High” not “outstanding” (O’Donnell 2000 reporting on older (1983) data). Its rank position, relative to other rivers ranked by the same old system, is unlikely to change if the system was used to re-assess the same rivers again today.

41. Under a revised value rating system O’Donnell (2000) scored 124 sites of the 279 assessed in the Canterbury Region as significant for indigenous birds. Of these he ranked 33 as “High 1” and 36 as “High 2” (covering nationally and internationally as well as regionally and nationally significant). A further 55 where “High 3” (regionally significant). These 124 sites represented the best examples in Canterbury. A further 148 sites were rated as moderate values.

42. O’Donnell ranked both the habitat and the presence of threatened species of that river separately.

43. Using O'Donnell's spread sheet data (2000) and summing the factor values allows a numerical ranking and value ranking. The Hurunui River ranks (for threatened species) as "High 3" (regionally significant) and for habitat as "High 2" (regionally and nationally significant). Of the 279 rivers assessed in the data base of O'Donell the Hurunui River scored at number 239 along with the Ashburton River mouth, the Waitaki River mouth, the Orari River mouth and Coopers Lagoon. This places the Hurunui in the top 14% of the Regions Rivers but not the top 5%. The top ranked water bodies were the Ashley River mouth, Avon-Heathcote estuary, Tekapo River, Ahuriri River and Lake Ellesmere. Water bodies just "higher" than the Hurunui River were Lake Tekapo, north branch of the Ashburton, Washdyke lagoon and Brookland lagoon.

44. If the Hurunui River is not in the Top 5 or even 10% of the Regions water bodies then it seems logical that it is not in the top National Rivers. Therefore the Hurunui River while "significant" for habitat (and possibly international significant under Ramsar criteria) does not appear to be, nevertheless, "outstanding" at a national level.

45. With regard to the Upper Hurunui River, the values lie in the Lakes and their deltas and the smaller branches and tributaries. Lake Sumner was ranked as H3 which is of Regional significance for habitat and H6 for threatened species (such as Australasian grebe), which means <10% of a category "c" or "o" species (a historic threat classification) uses the area. Lake Mary and Lake Mason rank as moderate rank of local significance (M1) only. None of the lakes as ranked by O'Donnell for birds, is high enough ranked to meet be nationally "outstanding".

46. Alone, or even in conjunction with the lakes the upper Hurunui River does not present itself as nationally "outstanding" with regard to aquatic/riverine bird species or habitat.

Terrestrial Organism summary

47. From review of the published data, primarily, on the ranking of birds and bird habitat in the Region by O'Donnell, but also having reviewed Dr Hughes evidence, and analysis of my own terrestrial survey data, I can find no evidence or numerical ranking that rates any portion of the Hurunui River or its flood plains with data as Nationally Outstanding.

Aquatic Organisms and their habitat

Trout Habitat quality

Water quality and the Physical Habitat

48. I largely concur with the applicants that the waters of both the south and north branches are good quality. My own sampling of the south branch in three locations in February of 2009 returned low to no contaminants in the water, as well as very low suspended phytoplankton. However, Lake Sumner in the west and the north branch of the river, historically, has suffered occasional algae blooms in the littoral zone (Bayly & Williams 1973) related to minor stock nutrient issues and (Anecdotally) still does.

49. It is noted by the applicant and many references (e.g. Hayward 2001) that the lower river is not in its natural state and that it has a number of seasonal water quality issues, not least being nutrient and bacteria. The primary reason for its inclusion, state the applicants, is in regard to fish passage. Fish passage is largely a function of channel depth, flow and contaminant loading i.e. volume and path of water.

50. Above the Mandamus the flow, the substrate and the bank/channel morphology are near natural, meaning they do not show particular signs of modification or degradation by human use or wider land use activities.

River Aquatic Macroinvertebrates and Productivity

51. Productivity is an important factor affecting the carrying capacity of the river (numbers and size of trout etc). It primarily relates to the

periphyton community and the macroinvertebrate community. It is most typically expressed as a dry weight per area or, as a proxy, the density of all or a particular set of aquatic macroinvertebrates. It is also acknowledged that a river's measurable productivity is very different at different times of the year (Scrimgeour 1991) making inter-river comparisons more difficult.

52. I do not present, or examine periphyton measures other than to note observations and remark on phytoplankton sample results. I primarily present aquatic macroinvertebrate data collected by myself and as represented in publications.

53. Data is scarce in regard to benthic invertebrates and their abundances in the upper Hurunui River (Meredith et al 2003 providing the most Hurunui data). I have recently sampled the South Branch at 18 locations and can formulate the same metrics as those used in other rivers to estimate productivity of the macroinvertebrate community. From that sampling, my knowledge of other east coast rivers and published literature from the Rakia, Rangatata, Wairau and Waitaki Rivers (using Ryder & Keesing 2006 and Jellyman & Graynorth 1994 (and references therein)) I have been able to make a general comparison of communities and "productivity".

54. The benthic macroinvertebrate community of the South Branch of the Hurunui is similar to other east coast rivers being dominated by *Deleatidium* with a prominent caddisfly and *Potamopyrgus* snail components and some what different in that *Pycnocentrodes* is most dominant numerically (Table 2). However, the Hurunui sampling also shows a prominence of Orthocladinae flies and Ostracods and Elmid beetles but not Chironomids. The last four groups are more common in less "pristine" waterways, and while the compositional balance is similar there are minor differences in the dominant groups and the spread of prominent groups.

Table 2. A compilation of survey data from various aquatic habitat types that expresses the dominant invertebrates in sampled communities in main stem habitats of the Rakaia, Rangitata, Waitaki and South Branch Hurunui Rivers, (* present, ** common, *** abundant)

	Rakaia River	Rangitata River	Waitaki River	Hurunui South Branch
Mayflies				
Deleatidium	***	***	**	***
Stoneflies				
Zelandobius	*	**	-	*
Beetles				
Elmidae	*	*	**	**
True flies				
Austrosimulium	*	**	*	*
Chironomidae	***	**	-	-
Orthocladiinae	-	***	*	**
Maoridiamesa	-	-	-	*
Tanypodinae	-	--	-	*
Caddisflies				
Aoteapsyche	**	*	**	
Beraeoptera	*	*	-	
Helicopsyche	-	*	-	
Pycnocentrodes	*	*	**	***
Pycnocentria	-	-	-	*
Oxyethira spp.				*
Worms	**	*	**	**
Flatworms	-	*	-	
Snails				
Potamopyrgus	*	*	**	**
Crustacea				
Paracalliope	-	*	*	
Ostracod				**

55. I have also compared a range of commonly used community metrics for the Hurunui South Branch, Waitaki and Wairau rivers, table 3 below. It can be seen that the South Branch braided river has a typical, or slightly lower, species richness, but generally higher EPT taxa than these comparison rivers. From the data I have, the South Branch Hurunui River, at least, does not stand out with regard to the aquatic macroinvertebrate community composition.

Table 3. Numbers of invertebrate taxa in the Wairau River, Waitaki River and South Branch Hurunui River. Data for the Wairau River was collected in November and December 2005 by Ryder & Keesing. Waitaki River data is sourced from Stark and Suren (2002) and Hurunui data from Keesing & Ryder 2008.

Statistic	**Warau River** [1]	**Waitaki River** [2]	**South branch Hurunui River**
	(± SE) [1]	**(± SE)** [2]	**(± SE)** [2]
Total number of taxa	49	57	41*
Mean number of taxa/sample	13.1 (0.3)	16.4 (0.7)	16 (1.0)
Mean number of EPT taxa	7.7 (0.2)	7.1 (0.3)	9.75 (0.68)
Percentage EPT taxa	59	43	58 (2.2)

* main stem and braid results. Total species richness including wetlands and side tributaries totals 60.

Invertebrate density (productivity proxy)

56. Table 4 below shows a comparison between the Wairau River, the Waitaki River (one big river and one river of similar flow to the middle Hurunui) and the South Branch of the Hurunui. It shows the number of various common taxa per metre square as a measure of invertebrate (fish food) abundance.

57. The data suggests that the South Branch of the Hurunui, at least, has comparable densities of *Deleatidium* mayfly and *Pycnocentrodes* caddisfly, but lower densities of other common species in the benthos. Table 4 shows that the South Branch had around 75% of the total density per square meter of the Waitaki River and a little higher density than the Wairau Rivers.

[1] Ryder and Ryder and Keesing, AEE and evidence for the Wairau HEPS Hearing 2006-2007
[2] Stark, J.D. and Suren, A.M. 2002. Project Aqua: Environmental Study - Aquatic Ecosystems: Macroinvertebrates. Prepared for Meridian Energy.

Table 4. Density (individuals per m^2) of selected invertebrate taxa from the Wairau River and Waitaki River. Data for the Wairau River was collected in November and December 2005-2006 by Ryder & Keesing. Waitaki River data is sourced from Stark and Suren 2002 and Stark 2006 and Hurunui data from Keesing & Ryder 2008.

Taxa	**Wairau River (no/m^2)[1]**	**Waitaki River (no/m^2)[2]**	**Hurunui South mid-branch (no/m^2)[3]**
Elmidae	425	1238	179.0
Pycnocentrodes	246	1029	1314.0
Deleatidium	1081	979	1165.5
Potamopyrgus	0.5	639	73.5
Aoteapsyche	144	237	38.9
Orthocladidae	220	116	74.9
Chironominae	198	63	0.9
Sum	2314.5	4301.0	2846.7

[1] – Ryder & Keesing, [2] – Stark, [3] Keesing & Ryder.

58. Table 5, shows that invertebrate densities are around the national "average" and middle ranking in terms of the rivers reported in table 5.

Table 5. Average invertebrate densities (individuals per m^2) from published records, listed in ascending order. And including my current Hurunui South Branch results.

River measured	Average density
Rakaia	647
Clutha	1451
Wairau	1592
Oreti	1915
Rangatata	1917
Whakapapa	1928
Wairau	2314
Ahuriri	2800
Wairau	2805
Hurunui Sth Branch	2846
88 NZ rivers average	2874
Karamea	2974
Mataura	3195
Motueka	3611
Glenariffle	3813
Horokiwia	4151
Waitaki	4301

Records from Stark 1991, Ryder & Keesing 2006, Richardson & Teirney 1982, Allen 1951, Jellyman & Graynorth 1994, Sagar 1983, Bonnett 1986, Jellyman et al 1982, Biggs &

Shand 1987, Witherow & Scott 1984, Boud & Cudby 1965, Mac Donald 1960, Boud et al 1962, Quinn & Hickey 1990.

59. The density of *Deleatidium* (as measured by me in November 2009) has around one half the density of the Ashley River as measured by Scrimgeour in that season.

60. The Hurunui, by this comparison, can be said to be a moderate-high productivity river at or around the national average based on densities of invertebrates.

61. The only comparative habitat quality (or productivity) data for the North Branch I have found is the modelled area of adult trout feeding habitat from Jowett's 1990 (and Teirny & Jowett), "100 rivers study". In this study he modelled **potential** adult feeding habitat based on velocity, depth and substrate measures for the Lake Sumner Outlet reach. The measure is not a direct one of productivity, in that it does not report sampled aquatic invertebrate densities or periphyton abundance or any actual food item, but it is a modelled theoretical potential quantity of feeding habitat and needs to be viewed as such. Nevertheless, of the 63 river sites which he provided this measure, the Lake Sumner outlet reach ranked as 6th (just within the top 10%) and therefore out side a 5% "Outstanding" threshold.

62. The data I have reviewed and collected does not suggest to me that the wider Hurunui River is generally more productive than most other east coast rivers, nor of different composition, nor contains special or unique fauna and **does not stand out** in that respect.

Trout abundance

63. I list in tabular form in appendix 1 the data from Teirney & Jowett (1990) and rivers from Jellyman & Graynoth 1994. This data is the result of drift dives around the country using near similar methods to count trout in size classes and make calculations on numbers per river area or length and biomass per area. Included are data from Ryder & Keesing 2007, 2008 on the Wairau River, as well as drift dive data of Keesing & Hooson 2009 on the South Branch of the Hurunui. I particularly use the results of Jowett in his 1990 publication of a 157 river drift dive trout survey and Jellyman & Graynorth (1994) in their

Headwater trout fisheries of New Zealand study. Several reaches of the Hurunui River can be ranked for trout populations relative to other rivers. The data allows three metrics, the number of total trout per km, the weight per kilometre, and a biomass per square metre.

64. Jellyman & Graynoth (1994), list 88 “A” list rivers (good fishing year round), and 41 “B” list rivers (seasonal good fishing). The South Branch of the Hurunui was identified in the “A” list (from angler survey records but not direct sampling) and the North Branch of the Hurunui was recorded in the “B” list.

65. The Jellyman & Graynoth records show brown trout in the South Branch at all seasons in the upper, middle and lower reaches of the South Branch. This is a different result than my recent fish survey results and I am inclined, despite a limited survey period, at this time, to rely more on my sampling data rather than the fishing record data. This is because that data is now some 25 years old and was angular reported data not actual sampled data.

66. The applicants, at section 62, presented similar but restricted data from similar sources, showing 10 of the 178 records in the database. The applicants table does not show the three top records for number of trout per km, their table contains the 1st, 10th, 22nd, 38th, 43rd and 95th ranked rivers. The table does show a selection of rivers already with a conservation order.

67. The full data set has three Hurunui locations for comparison: at the Lake Sumner outlet, below Lake Sumner and two measures for Lake Taylor. I have incorporated my drift data for the lower South Branch (under taken in January this year during a good visibility, low flow, stable period) and data obtained during surveys of the Wairau River in Marlborough.

68. The analysis shows that the Lake Sumner outlet ranks as 5th in regard to number of trout per kilometre; 5th in terms of Kg per kilometre; and 6th in terms of Biomass. Only the Buller the Gowan Rivers and two areas of the Tekapo rank higher.

69. When comparing the northern branch of the Hurunui, that area well below Lake Sumner and above the Sisters confluence, then the

Hurunui river ranks 27th in regard to number per kilometre, 29th in terms of kg trout per kilometre and 42nd in terms of biomass (kg/m^2).

70. Lake Taylor (the other Hurunui area measured) ranks between 102nd and 107th for the three metrics of 178 sites measured.

71. My lower South Branch drift dive measure of 131 fish over 10km, places the fish per km at 13.1 which ranks the lower south branch at 148th in rank. Using the same weight calculation factor as Jowett (1990) to calculate fish weights recorded from the drift dive, the South branch ranks as 150th.

72. There appears to be no comparable data for the lower Hurunui River below the Mandamus confluence, hindering a wider river ranking comparison.

73. Taking all this into consideration, the Hurunui catchment and the Hurunui River, in its wider context, has a wide variety of trout values. Only one area (the upper portion of the North Branch well above the Sisters Stream Confluence and below Lake Sumner outlet) is recognised as "high" in trout abundance and only that area falls within the top 10% of rivers in regard to numbers of trout per kilometre.

74. That reach of the North Branch ranks as "Outstanding" in terms of brown trout abundance and probably brown trout habitat. All other areas, tributaries and waterways measured in the Hurunui do not.

Aquatic Vegetation

75. A wide range of submerged and emergent aquatic macrophyte have been recorded in the Hurunui catchment in the various lakes and river. Most survey information comes from the work of Dr De Winton (De Winton et al 1991). Lake Sumner is the largest lake in the catchment with the most abundant and diverse community of aquatic plants (27 recorded species) predominantly made up of *Chara* spp., *Nitella* spp. *Isoetes alpinus*, *Myriophyllum, Potamogeton* and the exotic weed *Elodea Canadensis*. The other, smaller lakes have fewer species (Marion – 10, Katrine – 14, Taylor - 22, Sheppard - 22). The only recognised species of threatened status is the aquatic fern *Pilularia*

novae-zelandiae, found in Lake Sumner between 0.5 and 1.5 m (on the edge). In all of the lakes except Lake Marion, *Elodea* is abundant and a significant future weed issue. Only Lake Marion is free of exotic species (including exotic fish). Given this remarkable absence of exotic species as well as being in a good native vegetated state, Lake Marion, it seems can be considered exceptional and therefore "Outstanding". No other lake or area of aquatic vegetation in the wider region, with the data I have, can claim that, and it is likely few remain nationally.

Didymo

76. The presence of Didymo (*Didymosphenia geminata*) in the upper river (near the Jollie Brook confluence) is acknowledged by the applicants, but that the current infestation is in its early stages. The applicants say that they do not consider that the presence of didymo affects the outstanding highly natural aquatic habitat values.

77. I disagree. Based on the experiences of other rivers (Waiau, Wataki etc), Didymo can have a very large effect on the visual quality, fishablity and character of a river as well as potentially affecting productivity, species composition and habitat structure.

78. What is currently not well understood is the effect it has on the biota of a river. However, NIWA have shown that periphyton biomass, because of Didymo, can quickly develop to nuisance levels and that Didymo spread through a river can be very rapid (Norton 2007). Didymo seems particularly persistent in stable lake fed rivers with hard bottoms. Such rivers seem especially prone to rapid and extensive matting of this algae.

79. In the Waitaki Didymo has been recorded to form blooms that completely cover smaller braids and in larger braids extend several meters from the waters edge in towards the fast central channel. Norton (2007) records this as having negative effects aesthetically and for recreational users including fishmen and jet boaters.

80. Didymo is very tolerant of flow conditions and responds well to nutrients while still being very successful in low nutrient rivers. NIWA research suggests that normal New Zealand periphyton build up requires a flow of 450 cumecs to flush, but for Didymo the flush required is more like 600-900 cumecs (Norton 2007).

81. These flows, to my knowledge, do not annually occur in the upper Hurunui Catchment above the Mandamus. Mr Stewart in his evidence (pages 12-16) reports a maximum annual flood flow of 187 cumecs in the South Branch and a maximum record of 400; a maximum annual flood of 121 cumecs at the Lake Sumner outlet and a maximum record of 242 cumecs. Even combined, the maximum floods recorded might just remove a strong Didymo growth, the annual floods sum only to 308 cumecs (affecting only the river below the confluence) which is unlikely to remove Didymo.

82. To date research has shown that in the presence of Didymo the aquatic macroinvertebrate community composition remains relatively stable but a number of species grow in abundance at the “expense” of others. Viegalis (2007) reports that biomass of benthic and drift invertebrates increases and Norton shows those increases to be snails, worms, purse caddis and chironomids – the same response as to native algae blooms - while hard case caddisand mayfly abundances decline.

83. While it may well be that the trout fishery will not suffer from Didymo, the character of the invertebrate communities present, the physical character of the river and its margins and the fishability are likely to substantially change possibly in adverse ways for brown trout production and catchability.

84. The applicants note that much research is being done on eradication or control of Didymo. However, no successful control options presently exist and while optimism is held for research solutions currently the official position from Biosecurity New Zealand is that “no eradication methods are available” (MAF website, 2009).

Native fish

85. Twenty native species of fish have been recorded in the Hurunui Catchment (Armstrong 2006). Many of these species are found typically only in the lower river (such as black flounder Inanga, Stokell's smelt, giant kokopu and lamprey).

86. Above the Mandamus confluence, i.e. above the gorge and above the plains, seven native fish species have been reported (Armstrong, 2006, Grant 2001, FWDB 2009), with those being: long fin eel, short fin eel, koaro, Canterbury galaxid, alpine galaxid, upland bully and common bully.

87. In addition, I have sampled banded kokopu in the South branch and common smelt where previously recorded (in 1949) in Lake Marion and in Lake Sumner. Torrent fish are reported around the gorge and in the lower river but not in the upper river.

88. The most frequently encountered native fish above the Mandamus are the upland bully Canterbury galaxid, korao, and the Alpine galaxid. These are not threatened species.

89. With regard to threatened species occasional long fin eel are found in the lakes and occasionally in the rivers or tributaries and these are a species in "Gradual decline", None of the other 5 species with a threat status have been recorded above the Mandamus confluence (in the upper river).

90. Compared to other east coast rivers (e.g. Ashley, Rakia, Rangatata, Waitaki, South Ashburton, Waiau, Wairau etc) the species diversity of the upper river is not exceptional, but when considering the whole river it ranks as better than most east coast rivers, and is notable as one of the few rivers in the Region with banded kokopu populations. The densities or numbers reported, and caught by me, in the upper Hurunui are not of particular note.

91. As a whole, native fish densities are generally less than in the Ashley, but similar to the Waitaki and Rakia and Wairau (Keesing & Ryder 2006, Jellyman 2003).

92. While a good native fishery persists in the upper river and banded kokopu are a special feature regionally of the Hurunui, I still can not find evidence of it being “Outstanding” where outstanding means exceptional.

Effects of potential water management schemes

93. The Hurunui Water Trust (HWT) is preparing an application to develop in-river storage in the upper middle reaches and in-stream-transport of water down to the Mandamus confluence area followed by a river extraction and canal transport for irrigation use.

94. Boffa Miskell Ltd has been engaged to measure, record and assess the range of terrestrial and aquatic ecological values present and what effects can be anticipated based on a small set of scenarios of water storage, release, transport and up-take options.

95. Having been involved in scoping possible scenarios the current potential programme above the Mandamus confluence will require a large dam 12km up the South Branch and the raising of Lake Sumner by some 1.5-2m. In simple terms, the existing proposal is to store water during the autumn, winter and early spring months and discharge water over the remaining spring-summer months. Residual flows would be present on the South Branch and North Branch below Lake Sumner from about May through to October. After that flows would be higher than the current mean flow and be sustained through the irrigation months (October-April).

96. Currently the South Branch is relatively unbuffered by lakes or wetlands and high rain induced flows occur rapidly and cause large changes in the streams hydrologic condition. This supplies a substantial proportion of small to moderate variation in flow in the otherwise relatively stable main Hurunui Stem above the Mandamus confluence.

97. The proposed South Branch dam would bring increased stability to the South Branch river below the dam and retain the current relative stability in the North Branch. The discharge over summer in both

branches may improve the water habitat for invertebrate populations and fish by: reducing temperature stress, providing more water habitat, reducing periphyton / algae issues, and improving water quality through greater dilution.

98. Through the autumn, winter and early spring periods the residual flows will mean less water than typical, which could cause issues of contaminant dilution, algae growths etc. However, unlike in summer, those lowered flows will have less chance to result in temperature, water quality and algae issues because of the season, and contaminant levels are naturally very low.

99. A critical factor in the retention of all ecological values in the main stems will be the residual flow setting procedure which will address fish and productivity habitat requirements. It is proposed to use IFIM and habitat simulation modelling to assist in setting those winter residual flow parameters (Flow guidelines for in-stream values technical manual (NIWA 2008) and various Jowett, Hayes and Hudson methods and technical papers). In essence these methods will enable the project team to establish the bed–bank morphology, substrate and water velocities of the stream by replicated cross section measurement. These will then be used to model wetted usable area based on species preference information to indicate by modelling the quantity of suitable habitat at various flow regimes.

100. It will, in my opinion, be possible to run an irrigation storage scheme, that provides residual flows that adequately maintain the existing aquatic life as well as flow dynamics that change at a seasonal pace (rather than the daily peaking of a hydro-power station), such that the in-stream life will not be significantly adversely affected.

101. In regard to in-stream structures, particularly dams and weirs, the large South Branch dam structure, as it is currently envisaged, will prevent any existing up-stream fish passage. Above the Gorge this affects banded kokopu and koaro populations but not the Canterbury galaxid, alpine galaxid or up land bully.

102. In regard to brown trout, it is my opinion, from the work that I have done on the South Branch that the passage of trout, at least, is

infrequent beyond the “gorge” and that upper river fish generally come from the lake Mason population spawning. It is my opinion that trout passage is not required past the gorge in the South Branch to maintain the upper river trout populations and that these populations are currently serviced by Lake Mason and the spawning gravels around the Lake Mason - South Branch confluence. However, total isolation from new genetic stock could eventually be an issue but the avoidance of that affect can be managed.

103. The weir structure proposed to be fitted to the outlet of Lake Sumner to raise the lake up to around 2m higher will not be sufficiently high or of a design that will not allow fish passage. As I understand it, the weir will be a tilt-slab device that places the out flow at the river level and will allow swimming fish access at all times of migration.

104. As I understand the proposal it will not affect the likely drivers of the “outstanding” trout fishery at the lake outlet; those being a stable flow, lake seston, good water quality, good substrate and riparian and bank cover. It is my opinion that the catchment above the lake (in well forested DOC land mostly) and the lake itself provide the habitat below the lake that is outstanding for brown trout and these factors are little affected by the current water storage proposals.

105. The South Branch dam will also lead to the inundation of river turf lands and riverine bird nesting and feeding habitat of around 100 hectares and 80 hectares of river riparian wetland (i.e. affect aquatic and terrestrial organism). However, given that the values in this area in regard to water birds is not outstanding and there are no “outstanding” aquatic plants or plant communities, that inundation and the formation of a Lake has no affect on any Outstanding value.

106. This loss and change in riverine bird habitat, turf and wetlands will be a matter that is assessed and discussed through the resource consenting process, where through this process the values of the area and species and the effects on those values are fully assessed under matters of ecological significance and mitigation.

Conclusion

107. As far as the values considered by the water Conservation Order, related to section *199(2)(b)(i) Outstanding as a habitat for terrestrial or aquatic organisms*, are concerned I can not find the Hurunui River system above the Mandamus from an ecological or scientific perspective to be “outstanding” in terms of its brown trout habitat, productivity, aquatic vegetation, native fish populations or riverine bird life and their habitats.

108. The only area I can find that qualifies as nationally “Outstanding” in regard to brown trout numbers (and possibly habitat) is the immediate river area at the out let of Lake Sumner down stream for 3 or 4 km. This equates roughly to 2% (or less) of the applicants area of the Conservation Order. I do not consider that Outstanding values in a very small section of the system warrant the inclusion of the entire catchment especially when environmental parameters responsible for that value are largely protected in conservation lands and related to the lake or else a fish passage issue.

109. In regard to the effects of Didymo, I am of the opinion that Didymo, given the stable flows, channel type and relatively hard bottom substrate, will continue to spread and be persistent in the Hurunui and that its presence in substantial abundance will greatly reduce aspects of the “naturalness” of the upper Hurunui River.

110. In my opinion it would be possible to run an irrigation storage scheme such as that envisaged by the HWT that provides a flow regime that adequately maintain the existing aquatic and riparian life down stream of the storage areas as well as the persistence of the “Outstanding” trout population value down stream of the Lake Sumner outlet.

Dr Vaughan Keesing.

Dated 19 March 2009.

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Appendix 1

Tabulated results of drift dive surveys from the 100 rivers survey (Jowett 190 and Teiry & Jowett 1990, taken from Ryder and Keesing Wairau AEE and Ryder Evidence 2006-7). First shaded group (green) represent sites with 'high' trout abundance, second group (blue) represent sites with 'medium' abundance, third, un-shaded, group represent sites with 'low' abundance. Data sources: Fish & Game, Teirney & Jowett (1990), Ryder Consulting Limited (preliminary data for Wairau River). Trout abundance rankings as per Teirney & Jowett (1990): low (<15 kg/km - white), medium (15-35 kg/km - turquoise) and high (>35 kg/km - light green).

River	Site	Brown trout / km			Rainbow trout / km			No trout/km	Abundance (kg/km)	Biomass (g/m2)
		L	M	S	L	M	S			
Buller River	Lake Rotoiti outlet	117	290	1917	0	0	0	2324	301.9	16.1
Clutha River	Lake Wanaka outlet	179	22	2	63	10	2	278	291.5	3.2
Gowan River	Below outlet	144	125	79	0	0	0	348	208.8	8.3
Gowan River	Lake Rotoroa outlet	103	215	160	0	1	0	479	192.3	6.4
Hurunui River	Lake Sumner outlet	86	243	79	0	0	0	408	178.5	5.4
Arnold River	Kotuku	133	70	42	0	0	0	245	177.5	4.3
Motueka River	Woodstock	94	123	58	0	0	0	275	149.6	3.7
Haupiri River	Downstream of lake	103	63	53	0	0	0	219	140.9	4.7
Tekapo River	Below Maryburn	38	88	155	7	106	186	580	129.5	3.2
Tongariro River	Turangi	40	5	4	36	68	99	252	117.1	3.1
Mohaka River	Headwaters	77	37	58	1	0	0	173	103.9	4.5
Rai River	Above falls	45	55	23	11	60	7	201	103.8	4.6
Tekapo River	Willows	55	32	51	6	24	285	453	103.2	2.6
Grey River	Waipuna	36	156	53	0	0	0	245	92.4	1.4
Tauranga-Taupo River	Pump pool	1	1	1	33	133	127	296	90	5.2
Riwaka River	Moss Bush	70	26	15	0	0	0	111	89.4	7.2
Hutt River	Below Akatarawa forks	40	108	14	0	0	0	162	80.3	3.7
Rangitaiki River	Above Murupara	2	9	5	32	98	54	200	78.1	3.1
Waihou River	Whites Road	0	0	0	15	150	157	322	76	7
Wairau River	Below Wairau HEPS abstracted reach (n=8)	42	84	18	0	0	2	146	75.2	2
Mangles River	Gorge	49	25	55	0	0	0	129	67.1	4.1
Tekapo River	Above Pukaki River	28	34	16	11	28	22	139	66.9	3.6

Arnold River	Kokiri	52	22	3	0	0	0	77	66.7	1.4
Karamea River	Above bend	52	17	26	0	0	0	95	66.4	1.3
Mokihinui River	South branch	55	3	1				59	64.8	2.2
Aparima River	Above Otautau	29	94	11	0	0	0	134	63.4	2.1
Mararoa River	US water level recorder	24	4	2	20	29	10	89	61.8	2.3
Tekapo River	Above steel bridge	21	22	22	10	41	99	215	61.7	1.5
Maruia River	Paenga	42	32	21	0	0	0	95	59.7	1.5
Hurunui River	Below Lake Sumner (a)	36	50	52	0	0	0	138	59.3	1.8
Rangitikei River	Headwaters A	10	0	1	39	1	0	51	56.8	1.9
Karamea River	Bend	44	11	1				56	54.5	1.2
Waitaki River	20 cumec channel	34	39	35	0	0	0	108	53.2	1.9
Wanganui River	Kakahi	16	18	3	16	21	8	82	50.7	1.3
Karamea River	Above Crow hut	41	3	18	0	0	0	62	49.3	1.6
Mokihinui River	South branch	38	3	12	0	0	0	53	45.9	1.5
Inangahua River	Landing	30	29	16	0	0	0	75	44.8	0.8
Karamea River	Arapito	21	61	21	0	0	0	103	44.5	0.6
Hutt River	Whakatiki Street	4	130	0	0	0	0	134	44.4	1.8
Riwaka River	Moss Bush	35	9	1	0	0	0	45	43.8	3.5
Pelorus River	Maungatapu Road	23	12	6	7	5	55	108	42.8	1.4
Hutt River	Silverstream cut	31	20	8	0	0	0	59	42.5	1.1
Waitaki River	30 cumec channel	20	44	30	3	3	1	101	42.4	0.8
Rangitikei River	Mangaohane gorge	19	1	1	12	17	0	50	42.4	2.7
Karamea River	Crow River	35	2	1				38	41.3	1.4
Shag River	Dunbach	31	13	6	0	0	0	50	40.5	6.2
Ahaura River	Above Haupiri River	33	5	0	1	1	0	40	40.4	1
Mokihinui River	Cableway	21	42	67	0	0	0	130	40.1	0.9
Oreti River	Rocky Point	33	3	4				40	39.4	1.3
Buller River	Above Hope River	29	14	4	0	0	0	47	38.6	1.6
Kakanui River	Pringles	17	57	33	0	0	0	107	38.3	1.7
Tarawera River	Lake outlet	0	2	0	5	66	200	273	37.2	1.9
Hutt River	Silverstream bridge	18	48	26	0	0	0	92	37.1	1.1
Mohaka River	Glenfalls	12	21	23	10	11	22	99	36.8	0.9
Spring Creek	Odwyers Road	27	16	2	0	0	0	45	36.8	3.8
Oreti River	Above Mossburn	27	12	24	0	0	0	63	36.4	1.2
Mokihinui River	North branch	31	1	1	0	0	0	33	35.9	1.4
Oreti River	Below Gibraltar Rock	30	2	1				33	35.5	2.4

Rangitikei River	Springvale A	9	2	2	12	29	4	58	35.1	1.3
Manganuioteao River	Olivers bridge	22	8	1	4	2	4	41	33.5	0.7
Ahuriri River	SH bridge	8	19	17	5	34	7	90	33.2	0.8
Rangitikei River	Mangaohane A	16	1	0	5	23	4	49	32.8	1
Taruarau River	Headwaters	3	2	1	21	9	17	53	32	2.1
Hakataramea River	SH bridge	16	16	110	0	1	77	220	31.5	2.4
Aorere River	Devils Boots	20	23	14	0	0	0	57	31.5	0.6
Crow River	Lower	26	1	5				32	30.7	3.1
Manganuioteao River	Training pool	7	7	0	13	15	0	42	30.4	0.6
Ugly river		25	4	5				34	30.4	3
Selwyn River	Coes Ford	19	25	9	0	0	0	53	30.1	2.5
Spring Creek	Spring Creek	23	12	2	0	0	0	37	30.1	3
Rangitikei River	Headwaters B	5	0	1	21	0	1	28	29.8	0.9
Rangitikei River	Mangaohane A	2	0	0	14	34	1	51	29.6	0.9
Oreti River	Below Rocky Point	24	3	11				38	29.2	1
Wairoa River	Gorge	16	29	22	0	0	0	67	28.6	1.3
Rangitikei River	Pukeokahu	7	2	4	5	39	16	73	28.5	0.8
Rangitikei River	Mangaohane B	8	2	0	11	17	0	38	27.8	0.9
Rangitikei River	Mangaohane B	7	5	0	9	20	17	58	27.7	0.9
Manganuioteao River	Hoihenga bridge	14	4	2	6	8	3	37	27.7	0.6
Manuherikia River	Ophir	12	40	26	0	0	0	78	27.3	1.1
Whakapapa River	Oio	16	10	1	3	5	8	43	27.1	0.6
Baton River	Above concrete ford	16	24	17	0	0	0	57	26.5	1.5
Manganuioteao River	Mangamingi	15	0	0	7	1	0	23	25.8	0.5
Buller River	Below Lake Rotoiti	19	9	5	0	0	0	33	25.5	1.3
Ngaruroro River	Ngawapurua	6	1	0	14	5	5	31	25.2	1.3
Manganuioteao River	Possum Ridge	16	2	0	4	3	1	26	24.7	0.5
Mokihinui River	North branch	21	1	0				22	24.7	1
Taramakau River	Kumara	14	20	5	1	1	3	44	23	0.2
Mangatainoka River	Tui brewery	12	28	4	0	0	0	44	22.7	0.9
Irthing Stream	Water level recorder	12	12	131	0	0	0	155	22.6	1.1
Rangitikei River	Springvale B	10	2	1	5	12	3	33	22.3	0.6

Waingongoro River	Eltham	14	20	5	0	0	0	39	22.2	2.8
Manganuioteao River	Ram paddock	12	7	2	4	4	5	34	22.2	0.5
Ruamahanga River	Wardells	18	4	0	0	0	0	22	22.2	0.7
Mataura River	Nokomai	16	11	9	0	0	0	36	21.9	0.9
Taruarau River	Headwaters	7	0	2	11	2	5	27	21.8	1.6
Takaka River	Kotinga bridge	17	8	2	0	0	0	27	21.7	0.3
Inangahua River	Blacks Point	4	26	204	0	0	0	234	21.4	1.2
Whakapapa River	Owhango	9	9	5	5	5	27	60	21.4	0.5
Tekapo River	Above Grays River	6	1	1	2	29	39	78	21.2	0.9
Opihi River	SH 1 bridge	15	9	3	0	0	0	27	20.8	0.9
Waimakariri River	SH 5 bridge	0	0	0	0	36	193	229	20.7	1.9
Akatarawa River	West Akatarawa Road	17	3	1	0	0	0	21	20.2	1.5
Waikaia River	Piano Flat	11	19	9	0	0	0	39	19.5	0.7
Waitahu River		13	14	0				27	19.4	1
Selwyn River	Whitecliffs	8	29	41	0	0	0	78	19.3	1.4
Oreti River	Gibraltar Rock	16	1	1				18	18.9	1.9
Hurunui River	Lake Taylor (b)	13	9	8	0	0	0	30	18.6	0.7
Manganuioteao River	Manaturuturu	5	0	0	9	2	1	17	16.2	0.3
Otaki River	Swingbridge	10	12	2	0	0	0	24	15.9	0.7
Whakapapa River	Kakahi	3	3	7	8	1	7	29	15.1	0.3
Moawhango River	Moawhango	12	2	1	0	0	0	15	15	1.1
Tekapo River	Above steel bridge	1	6	7	0	30	17	61	14.7	1
Ngaruroro River	Whanawhana	2	2	0	5	15	5	29	14.3	0.6
Patea River	King Edward Park	8	12	19	0	0	0	39	14.1	1.5
Waipapa River	Water level recorder	0	0	0	6	17	29	52	13.7	0.6
Hurunui River	Lake Taylor (c)	10	7	0	0	0	0	17	13.7	0.5
Whakapapa River	Otamawairua	7	1	0	4	1	0	13	12.6	0.4
Waitaki River	5 cumec channel	7	11	7	0	0	0	25	12.2	0.7
Waitaki River	15 cumec channel	7	9	5	0	1	0	22	11.7	0.5
Tarawera River	Below falls	0	0	0	8	7	0	15	11.7	1.2
Wairau River	Within Wairau HEPS abstracted reach (n=11)	8	3	7	0	0	1	20	11.3	0.5

Mangahao River	Ballance bridge	8	6	1	0	0	0	15	11.1	0.4
Taruarau River	Taihape Road	4	1	1	1	6	81	94	10.9	0.9
Takaka River	Harwoods	6	10	16	0	0	0	32	10.3	0.6
Hautapu River	Abattoir Road	9	1	0	0	0	0	10	10.3	0.8
Rangitikei River	Mokai	3	2	0	2	10	1	18	9.7	0.2
Waimana River	Gorge	8	3	4	0	0	0	15	9.6	0.4
Waiwakaiho River	SH 3	7	3	7	0	0	0	17	9.3	0.6
Crow River	Upper	6	2	28				36	8.7	0.6
Ngaruroro River	Kuripapango	2	3	1	2	7	14	29	8.6	0.4
Waitaki River	10 cumec channel	5	7	10	0	0	0	22	8.5	0.4
Wairau River	Above Wairau HEPS abstracted reach (n=7)	5	8	29	0	0	0	42	8.1	0.4
Clarence River		5	7	3				15	8.1	0.8
Stony River	Okato	4	3	4	0	3	6	20	7.4	0.6
Waingawa River	Water level recorder	6	3	0	0	0	0	9	7.4	0.5
Tongariro River	Waipakahi River	0	0	0	0	16	42	58	7.3	0.3
Rangitikei River	Headwaters C	4	0	0	2	1	1	8	7.3	0.5
Manganuioteao River	Ruatiti Stream	2	2	0	2	4	0	10	7.1	0.1
Pohangina River	Raumai	5	4	5	0	0	0	14	6.9	0.3
Waitahu River		3	6	37				46	6.8	0.3
Waioeka River	Gorge	0	0	0	3	8	3	14	6.7	0.2
Larrys Creek		5	2	2				9	6.5	0.4
Manganui River	Croyden Road	4	6	6	0	0	0	16	6.4	0.4
Ohau River	Gladstone Road	5	2	10	0	0	0	17	6.3	0.4
Waipawa River	Fletchers Crossing	1	0	4	4	1	4	14	6	0.4
Waimana River	Ogilvies Bridge	2	0	0	2	2	2	8	5.3	0.3
Otematata River	Pumphouse	1	2	27	1	1	16	48	5.2	0.3
Esk River	Eskdale Park	3	3	3	0	0	19	28	5.1	0.4
Kaupokonui River	Skeet Road	0	16	8	0	0	0	24	5.1	0.5
Stoney	Inangahua confluence	4	1	1				6	5	0.5
Whakatiki River	Bulls Run Road	4	1	5	0	0	0	10	4.8	0.5
Wanganui River	SH 47	4	0	0	1	0	2	7	4.8	1.1
Whakapapa River	Intake	1	0	0	3	0	0	4	4.8	0.2

Ahuriri River	Thomas's	1	1	1	1	6	10	20	4.6	0.2
Waikanae River	Treatment plant	4	1	1	0	0	0	6	4.6	0.2
Tutaekuri River	Puketapu Bridge	0	0	0	2	2	22	26	4.4	0.2
Makaroro River	Makaroro Road	0	0	1	3	1	0	5	4.4	0.4
Tauherenikau River	Water level recorder	3	0	10	0	0	0	13	4.1	0.3
Taipo River	Gorge	3	2	1	0	0	0	6	4.1	0.1
Ruamahanga River	SH 2 bridge	3	0	0	0	0	0	3	3.6	0.2
Hutt River	Taita Rock	2	4	0	0	0	0	6	3.5	0.1
Orari River	Gorge	0	9	18	0	0	0	27	3.3	0.2
Whakapapa River	Whakapapanui	0	0	0	2	2	3	7	2.8	0.1
Waimakariri River	Groyne 0	1	3	1	0	0	0	5	2.6	0.1
Maerewhenua River	Kellys Gully	1	2	10	0	0	13	26	2.5	0.2
Waiohine River	Gauge	1	4	6	0	0	0	11	2.5	0.1
Pomahaka River	Hukarere	2	2	2	0	0	0	6	2.5	0.2
Mangorewa River	Water level recorder	0	0	0	2	0	0	2	2.3	0.2
Kakanui River	Upper	2	0	0	0	0	0	2	2.2	0.3
Kaurenga River	Water level recorder	0	0	0	1	3	1	5	1.8	0.1
Opihi River	Rockwood bridge	1	1	16	0	0	0	18	1.7	0.1
Ahuriri River	Above Birchwood	2	0	0	0	0	0	2	1.7	0.1
Patea River	Above Stratford intake	1	0	1	0	0	0	2	1.2	0.3
Tairua River	Above Broken Hills	0	0	0	1	1	2	4	0.8	0
Oroua River	Fielding Road	0	2	0	0	0	0	2	0.5	0
Waiari Stream	Muttons farm	0	0	0	0	0	1	1	0	0
Tukituki River	Fairfield Road	0	0	0	0	0	0	0	0	0